

extend the records of the species. We are also indebted to Mr. C. E. Faxon for his detailed drawings, and to Mr. F. Schuyler Mathews for the skillful retouching by which the photographs have been prepared for half-toning.

## NOTES ON ARCEUTHOBIUM PUSILLUM.

HERMANN VON SCHRENK.

(Plate 12.)

IN the latter part of the year 1871, Mrs. Lucy A. Millington found a small mistletoe on the black spruce, *Picea Mariana*, B.S.P. (*P. nigra*, *Ait.*) at Warrensburg, Warren County, New York and about the same time Prof. C. H. Peck discovered the same plant at Sandlake, Rensselaer County, New York. Specimens were sent to Dr. Engelmann who recognized in the plant an *Arceuthobium* which he called *Arceuthobium minutum*.<sup>1</sup> Much astonishment was expressed at the time that this curious plant had not been found before, and we find numerous accounts of it in the periodical literature of that day.<sup>2</sup> Collectors searched for new stations with great zeal and a number of these were found in New York (notably in Sullivan County), in Pennsylvania, and in New Hampshire. The mistletoe in all these localities was confined to the black spruce, growing in cold sphagnum bogs. Peck described the plant in 1872, as *Arceuthobium pusillum*.<sup>3</sup>

For many years nothing more was heard of the plant. A number of species, many of which had extended ranges, were found on various Coniferae in the far west. Recently the interest in this, the smallest of the mistletoes, revived and several observers report finding it in localities not known before, from Vermont, Massachusetts, and Maine.

During the past summer a group of white spruces on Monhegan Island (near Boothbay Harbor), Maine, was found covered with the *Arceuthobium*. The trees were much stunted, some of them were dead, and the living ones formed a striking contrast to their healthy neighbors, because of their short yellow leaves. It was thought rather

<sup>1</sup> Bull. Torr. Bot. Club **2**: 43, 1871. Proc. Acad. Sci. St. Louis **3**: LXXXIII, 1873 (presented May 20, 1872).

<sup>2</sup> Bull. Torr. Bot. Club **2**: 42, 47, 48, 1871; **3**: 24, 55, 1872; **4**: 15, 44, 1873. Proc. Acad. Sci. St. Louis **3**: LXXXIII, 1873. American Naturalist **6**: 166, 406, 1872.

<sup>3</sup> Peck, C. H., 25 Ann. Report State Botanist, N. Y., p. 69, 1873.



odd that the mistletoe should occur on an island at least five miles from the nearest mainland, and a vigorous search was made on the coast of the mainland for the plants. Hundreds of trees were found about Boothbay Harbor and Linekin, on which the mistletoe grew in quantities. The trees attacked varied from such as were but a few feet in height to the tallest in the forest, often eighty feet in height. The affected trees all grew within an eighth of a mile of the shore. This local distribution is probably due to the fact that an atmosphere laden with moisture is necessary in order that the seeds may be properly discharged. The fogs which are so prevalent during the months of August and September bring about these conditions, which will be most favorable near the coast.

As the accounts which have appeared up to this time give but short and scattering notes, a brief description of the plant may be of interest. In the unpublished notes of Dr. Engelmann, there are many drawings and descriptions, made at the time when the plant was discovered, which will be published, together with a fuller account of the plant and its western allies, in a more extended form.

The mistletoe is usually found on the younger branches of the spruces.<sup>1</sup> Many stems grow out from the host branch, sometimes twelve to sixteen stems in an inch. The individual stems vary between wide extremes as respects size and color. Both characters depend so much on the vigor of the host branch that this variability is to be expected. On very strong branches the stems are dark brown, almost black, and vary from half an inch to an inch or more in height. On weaker branches the plants are paler in color, and usually have a more spindling shape. The vigor of the host plant is, however, not the only factor, exposure to the direct rays of the sun, the number of stems in a given length of the host stem, and probably other factors determine the character of each stem. One finds strong, dark-colored stems in the midst of a dense broom, and, again, very pale ones.

The influence of the *Arceuthobium* on its host is probably the most marked feature of this interesting plant. In many cases where a parasite attacks a host-plant, the latter reacts in one way or another, as if stimulated. Increased growth takes place, new tissues and organs are formed, which are in striking contrast to the normal habit of the host. *Arceuthobium pusillum* stimulates its host to a greater degree

<sup>1</sup> In the following, by spruce, *P. Canadensis*, B. S. P. (*P. alba*, Link), will be understood.



than its western relatives do theirs. The stimulus takes the form of an increased growth, both in length and in the number of branches. This growth is of two kinds. If a seed germinates on a weak branch, which is shaded or much crowded, the affected branch grows to be several times its normal length. After several years a very open system of branches has resulted. The lateral branches of the spruce are but one or two inches apart; but on a large branch affected with the mistletoe, the points where lateral branches leave the main branch are often eight to twelve inches apart. Where a seed falls on a vigorous branch a very different form of branching results. Two stages of this are represented on the accompanying plate. The small branchlet nearest the germinating seed assumes a vertical position, and grows abnormally long during the first year. The next year several branches appear at its base, and both the main shoot and these fringing branches shortly give rise to others. After several years a very decided clump of branches grows in the form of a small bush, standing vertically on the horizontal branch. The small bush or broom gradually appropriates the food supply of the branch, and that part of the main branch beyond its base gradually weakens and dies. Thus it may happen that ultimately the broom appears to be at the end of a strong branch. These brooms grow to be very large. On some of the tall spruces several were measured which were two feet wide and four feet high. A tall spruce covered with these brooms is truly a strange object.

The leaves of the lengthened stems as well as those on the brooms are very much shorter than the normal spruce leaves, and paler in color, often quite yellow. The age of the brooms varies with the vigor of the host tree. The brooms when once they cover a tree are a great strain on its vitality, and it very soon weakens and dies. Dead trees with the old brooms are surprisingly numerous on that portion of the Maine coast alluded to. That this seemingly obscure plant is very destructive to the spruce is evident. After the parasite has once obtained a foothold in a group of spruces, it will not be long before all are affected, thanks to the effective bombardment of their branches by the small fruit mortars.

The manner in which the seeds are disseminated differs but little from that recently described by MacDougal.<sup>1</sup> A fact which Mrs. Millington speaks of in a letter to Dr. Engelmann is the way in which

<sup>1</sup> MacDougal, D. T. Seed dissemination and distribution of *Razoumofskya robusta* (Engelm) Kuntze, Minn. Bot. Studies 2 Series, pt. II, p. 169, 1899.



the stems bend toward the newer branches as the seeds ripen. This was very marked on the spruces about Linekin. Towards the latter part of September, the stems became inclined towards the outer part of the tree. This brought the axes of the berries into a line almost parallel with the branch upon which the plants grew, i. e., with the ends from which the seeds were to fly toward the outside of the tree. The last week in September, the berries were ripe, and every day the seeds were shot out, flying out upon the newer branches. The manner in which the spirally marked hairlike cells glue the seeds to the bark will later be described more in detail.

The longitudinal arrangement of the stems on a branch has given rise to the supposition that they spring from longitudinal rhizomes, which grow in the bark of the host. This system of rhizomes is a very complex one. A network of threads grows out from the base of each stem, one thread fusing with another before long. From these threads the actual absorbing organs, the haustoria, are developed much as in the true mistletoes.

The distribution of this mistletoe is an interesting one. There seems to be little doubt now that birds in some cases carry the seed from place to place, for they must have carried them to Monhegan Island. Its occurrence in moist swamps and along the coast has been alluded to, and it is to be hoped that collectors in the New England States will watch for the plants, that we may be able before long to establish a complete chain from its furthest western to its most eastern station. Specimens will gladly be supplied on application.

SHAW SCHOOL OF BOTANY.

EXPLANATION OF PLATE 12.—Fig. 2. Horizontal branch of white spruce, *Picea Canadensis*, B. S. P. (*P. alba*, Link) with very young witches' broom. The latter is two years old. Note the strong buds on the branches of the broom, both terminal and lateral. About one-fourth natural size. Fig. 1. Older witches' broom of the white spruce. The stems of the *Arceuthobium* cover the branches, but are too small to be visible in the photograph. Note how the terminal part of the main horizontal branch is dying, also how the main stem of the broom is now thicker than the original host branch. Note the length of the annual growth of the broom branches, compared with that of the host branch. About one-fourth natural size.